

Appendix C

Computer Program Axiltr

C-1. Organization

Program AXILTR, AXial Load-Transfer, consists of a main routine and two subroutines. The main routine feeds in the input data, calculates the effective overburden stress, and determines whether the load is axial down-directed, pullout, or if uplift/downdrag forces develop from settling or consolidating soil. The main routine also prints out the

computations. Subroutine BASEL calculates the displacement at the base for given applied down-directed loads at the base. Subroutine SHAFL evaluates the load transferred to and from the shaft for relative displacements between the shaft and soil. An iteration scheme is used to cause the calculated applied loads at the top (butt) to converge within 10 percent of the input load applied at the top of the shaft.

a. Input data. Input data are illustrated in Table C-1 with descriptions given in Table C-2.

Table C-1
Input Data

Line	Input Parameters	Format Statement
1	TITLE	20A4
2	NMAT NEL DX GWL LO IQ IJ	2I5,2F6.2,3I5
3	I J K SOILP DS DB	3I5,3F10.3
4	E50 (Omitted unless K = 2, 5, 9)	E13.3
5	LLL	I5
6	MAT GS EO WO PS CS CC C PHI AK PM (Lines 5 repeated for each material M = 1,NMAT)	I3,3F6.2,F7.0,2F7.2,
7	ALPHA (Omitted unless I = 6) (α input for each material MAT = 1,NMAT)	7F10.5
8	M IE(M) (Line 8 repeated for each element M and number of soil IE(M). Start with 1. The last line is NEL NMAT)	2I5
9	RFF GG (Omitted unless K = 7, 8, 9)	F6.3,E13.3
10	(Omitted unless K = 3, 4, 5, 6)	
10a	NCA (<12)	I5
10b	T(M,1)... T(M,11) (Input for each curve M = 1,NCA)	11F6.2
10c	S(M) (Input on new line for each M = 2,11; S(1) input in program as 0.00)	F6.3
11	(Omitted unless I = 5)	
11a	NCC (<12)	I5
11b	FS(N) ZEPP(N) NCUR (Input on new line for each N = 1,NCC)	2F10.3,I5
12	(Omitted unless J = 0)	
12a	NC (>1)	I5
12b	EP(M) ZEP(M) (Input on new line for each M = 1,NC; at least a top and bottom term required)	E13.3,F6.2

Table C-1 (Concluded)

Line	Input Parameters	Format Statement
13	R(M) S(M) (Omitted unless K = 6; repeat on new line for each M = 1,IJ)	F10.5,F15.3
14	STRUL SOILP XA	3F15.2
15	NON (Omitted unless XA < 0.0)	I5

Table C-2

Description of Input Parameters (Continued)

Line	Parameter	Description
1	TITLE	Name of problem
2	NMAT	Total number of materials
	NEL	Total number of elements
	DX	Thickness of each element, ft (usually 0.5 or 1.0 ft)
	GWL	Depth to groundwater level, ft
	LO	Amount of output data = 0 Extensive data output used to check the program = 1 Shaft load-displacement behavior and detailed load distribution-displacement response along shaft length for input top load prior to and following soil distribution-displacement response along shaft length for input top load prior to and following soil movement (load transfer, load, shaft compression increment, and shaft movement at given depth) = 2 Shaft load-displacement behavior and load distribution-displacement response along shaft length for input top load prior to and following soil movement = 3 Shaft load-displacement behavior and load distribution-displacement response along shaft length for input top load on shaft following soil movement
	IQ	Total number of shaft increments (shaft length/element thickness); top of shaft at ground surface
	IJ	Number of points for shaft load-displacement behavior (usually 12, but maximum 19 for PARAMETER statement = 40)
3	I	Magnitude of reduction factor α applied to total (undrained) or effective (drained) shear strength for skin friction resistance = 0 $\alpha = 1$ (usually used for drained strength) = 1 $\alpha = \sin(\pi x/L)$, x = depth, ft; L = shaft length, ft = 2 $\alpha = 0.6$ = 3 $\alpha = 0.45$ = 4 $\alpha = 0.3$ = 5 α = Permits maximum skin friction input as a function of depth, psf (see line 11) = 6 α = input for each material (see line 7)
	J	Option for elastic shaft modulus = 0 shaft modulus input = 1 shaft modulus set to near infinity

(Sheet 1 of 3)

Table C-2 (Continued)

Line	Parameter	Description																						
	K	Option for load-transfer functions (see Figure 3-22)																						
		<table border="1"> <thead> <tr> <th>Base</th> <th>Shaft</th> </tr> </thead> <tbody> <tr> <td>= 0 Consolidation</td> <td>Seed and Reese</td> </tr> <tr> <td>= 1 Vijayvergiya</td> <td>Seed and Reese</td> </tr> <tr> <td>= 2 Reese and Wright</td> <td>Seed and Reese</td> </tr> <tr> <td>= 3 Consolidation</td> <td>Input (see line 10)</td> </tr> <tr> <td>= 4 Vijayvergiya</td> <td>Input (see line 10)</td> </tr> <tr> <td>= 5 Reese and Wright</td> <td>Input (see line 10)</td> </tr> <tr> <td>= 6 Input (see line 13)</td> <td>Input (see line 10)</td> </tr> <tr> <td>= 7 Consolidation</td> <td>Kraft, Ray, and Kagawa</td> </tr> <tr> <td>= 8 Vijayvergiya</td> <td>Kraft, Ray, and Kagawa</td> </tr> <tr> <td>= 9 Reese and Wright</td> <td>Kraft, Ray, and Kagawa</td> </tr> </tbody> </table>	Base	Shaft	= 0 Consolidation	Seed and Reese	= 1 Vijayvergiya	Seed and Reese	= 2 Reese and Wright	Seed and Reese	= 3 Consolidation	Input (see line 10)	= 4 Vijayvergiya	Input (see line 10)	= 5 Reese and Wright	Input (see line 10)	= 6 Input (see line 13)	Input (see line 10)	= 7 Consolidation	Kraft, Ray, and Kagawa	= 8 Vijayvergiya	Kraft, Ray, and Kagawa	= 9 Reese and Wright	Kraft, Ray, and Kagawa
Base	Shaft																							
= 0 Consolidation	Seed and Reese																							
= 1 Vijayvergiya	Seed and Reese																							
= 2 Reese and Wright	Seed and Reese																							
= 3 Consolidation	Input (see line 10)																							
= 4 Vijayvergiya	Input (see line 10)																							
= 5 Reese and Wright	Input (see line 10)																							
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= 9 Reese and Wright	Kraft, Ray, and Kagawa																							
	SOILP	Pressure on top layer of soil exerted by surrounding structure, fill, etc., psf																						
	DS	Diameter shaft, ft																						
	DB	Diameter base, ft																						
4	E50	Strain at 1/2 maximum deviator stress, Equation 3-34																						
5	LLL	Option for type of shear failure at base = 0 Local shear failure, Equation 3-24 or $N_c = 7$ = 1 General shear failure, Equation 3-10 or $N_c = 9$																						
6	MAT	Number of material																						
	GS	Specific gravity																						
	EO	Initial void ratio																						
	WO	Initial water content, percent																						
	PS	Swell pressure, psf																						
	CS	Swell index																						
	CC	Compression index																						
	C	Cohesion, psf; = undrained strength for total stress analysis; effective cohesion c' or zero for effective stress analysis																						
	PHI	Angle of shearing resistance ϕ ; = 0 for total stress analysis																						
	AK	Coefficient of lateral earth pressure																						
	PM	Maximum past pressure, psf (program sets PM = PS if PM input < PS)																						
7	ALPHA	Reduction factor α_a for each material MAT, Equations 3-26, Table 3-5, Table 3-9;; used when option I = 6, Line 3																						
8	M	Number of element																						
	IE(M)	Material number of soil, MAT																						
9	RFF	Hyperbolic reduction factor R for Kraft, Ray, and Kagawa model, Equation 3-35; use 1.0 if not known																						
	GG	Shear modulus G, psf, Equation 3-35																						
10		Input data for shaft load-transfer curves ($k = 3, 4, 5, 6$)																						
10a	NCA	Total number of shaft load-transfer curves to input, < 12																						
10b	T(M,1)... ..T(M,11)	Skin friction ratio of developed shear strength/maximum mobilized shear strength of each shaft load-transfer curve; 11 values required for each load-transfer curve, the first value T(1,1) = 0.0																						
10c	S(M)	Movement in inches for all of the T(M,1)...T(M,11) curves; only 10 values required from S(2)...S(11); S(1) = 0.0 in code; if S(M) in the code is okay (0.0, 0.05, 0.1, 0.15, 0.2, 0.23, 0.3, 0.45, 0.75, 1.05, 1.5 inches)																						

Table C-2 (Concluded)

Line	Parameter	Description
11	NCC	Input data for maximum skin friction as a function of depth Total number of maximum skin friction terms to input, <12; program interpolates maximum skin friction between depths
11a	FS(N)	Maximum skin friction f-, for point N, psf
11b	ZEPP(N)	Depth for the maximum skin friction for point N, ft
11c	NCUR	Number of the shaft load-transfer curve input M in line 10; applicable to the maximum skin friction for point N (Repeat 11a, 11b, 11c for each N = 1,NCC)
12		Input data for shaft elastic modulus as function of depth; program interpolates the elastic modulus between depths
12a	NC	Total number of terms of elastic modulus and depth, > 1
12b	EP(M)	Elastic modulus of shaft at point M, psf
	ZEP(M)	Depth for the elastic modulus of shaft at point M, ft (An elastic modulus and depth term are required at least at the top and bottom of the shaft)
13		Input data for base displacements if K = 6 (The number of input terms or R(M) and S(M) equals IJ - 1, line 2
13a	R(M)	Base displacement, in. (The first displacement is 0.0 inches and already input in the program)
13b	S(M)	Base load for displacement R(M), pounds; the base load for 0.0 displacement is approximated as the overlying soil weight and already input in the program
14		Structural load, pressure on adjacent soil at the ground surface, and depth of the active zone for heave input for each problem for evaluation of specific load distribution-placement computations
14a	STRUC	Structural vertical load on top of shaft, pounds
14b	SOILP	Pressure on top layer on soil exerted by surrounding structure, fill, etc., psf
14c	XA	Depth of the active zone for heave, ft; = 0.01 yields load-displacement behavior for zero soil movement; a saturated soil profile is assumed when computing soils movement; < 0.0 program goes to line 15 below
15	NON	Execution stops if 0; program goes to line 1 if > 0

(Sheet 3 of 3)

(1) The program is set to consider up to a total of 40 soil types and 100 soil elements. Figure C-1 provides an example layout of soil types and elements used in AXILTR.

(2) The program can accommodate up to 18 points of the load-displacement curve. This capacity may be altered by adjusting the PARAMETER statement in the program.

(3) The input data are placed in a file, "DALTR.TXT." These data are printed in output file, "LTROUT.TXT," illustrated in Table C-3a.

b. *Output data.* Results of the computations by AXILTR are printed in LTROUT.TXT illustrated in Table C-3b. Table C-3c provides a description of calculations illustrated in Table C-3b.

(1) Load-displacement data are placed in file LDCOM.DAT for plotting by graphic software.

(2) Load-depth data for a given applied load on the pile top are placed in file LDSP.DAT for plotting by graphic software.

(3) Displacement-depth data for a given applied load on the pile top are placed in file MDEP.DAT for plotting by graphic software.

C-2. Application

The pullout, uplift, and downdrag capabilities of AXILTR are illustrated by two example problems. The accuracy of these solutions can be increased by using more soil layers, which increases control over soil input parameters such as swell pressure, maximum past pressure, and shear strength.

a. *Pullout and uplift.* Table C-4 illustrated input data required to determine performance of a 2-feet-diameter drilled shaft 50 feet long constructed in an expansive clay soil of two layers, NMAT = 2. The shaft is underreamed of two layers, NMAT = 2. The shaft is underreamed

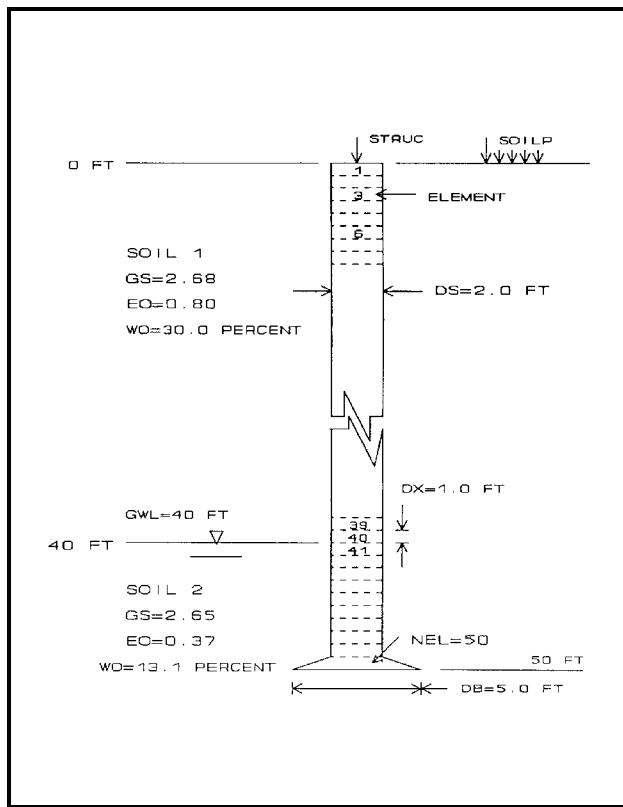


Figure C-1. Schematic diagram of soil and pile elements

with a 5-foot-diameter bell. Soil beneath the shaft is nonexpansive. The shaft is subject to a pullout force of 300 kips. Refer to Figure C-1 for a schematic representation of this problem.

(1) Bearing capacity. The alpha skin friction and local shear base capacity models are selected. Option to input the reduction factor "I" (I = 6) was used. The selected "I's for the

two soils is 0.9. A high "I" was selected because expansive soil increases pressure against the shaft, which may raise the skin friction.

(2) Load-transfer models. The Kraft, Ray, and Kagawa skin friction and the Vijayvergya base load-transfer models ($K = 8$) were selected. Two points for the elastic modulus of the shaft concrete were input into the program.

(3) Results. The results are plotted in Figure C-2 for a pullout force of 300,000 pounds. Results of the computation placed in files "LTROUT.TXT" are shown in Table C-5.

(a) Total and base ultimate bearing capacity is about 1,200 and 550 kips, respectively (Figure C-2a). Base and total capacity is 250 and 600 kips, respectively, if settlement is limited to 0.5 inch, which is representative of an FS of approximately 2.

(b) The distribution of load with depth, Figure C-2b, is a combination of the shapes indicated in Figures 3-15 and 3-16, because both pullout and uplift forces must be resisted.

(c) The shaft will heave approximately 0.7 inch, while the soil heaves more than 11 inches at the ground surface (Figure C-2c).

b. Downdrag. Table C-6 illustrates input data required to solve for the performance of the same drilled shaft and soil described in the previous example problem, but the soil is wetter with a much lower swell pressure. Soil shear strength is assumed not to change significantly from the previous example. This shaft is subject to a 150-kip load in addition to the downdrag forces from the settling soil.

(1) Bearing capacity. The alpha skin friction and local shear base capacity models are selected similar to the previous example. Option to input the reduction factor α 's are 0.55 and 0.3 for the surface and deeper soils, respectively.

Table C-3. Output Data

a. Repeat of Input Data (See Table C-1)

Line	Input Parameters						Format Statement
1	TITLE						20A4
2	NMAT=	NEL=	DX=	FT	GWL=	FT	I5,I5,F6.2,F6.2
	LO=	IQ (SHAFT INC)=			IJ (NO.LLOADS=		I5,I5,I5
3	I=	J=	K=		SOILP=	PSF	I5,I5,I5,F10.2
	DS=	FT					F10.2
	DB=	FT					F10.2
4	(If K = 2, 5, 9)						E13.3
	E50						
5	LOCAL SHEAR FAILURE AT BASE - LLL = 0 Or						I5
	GENERAL SHEAR FAILURE AT BASE - LLL = 1						I5
6	MAT GS EO WO (%) PS(PSF) CS CC CO(PSF) PHI K PM(PSF)						I3,3F6.2,F7.0,27.2, F7.0,2F6.2,F7.0
7	(If I = 6) ALPHA =						2(7F10.5)
8	ELEMENT	NO OF SOIL					I5,10X,I5
9	(If K = 7, 8, 9)						F6.3,3X,E13.3
	REDUCTION FACTOR=	SHEAR MODULUS=					
10	(If K = 3, 4, 5, 6)						I5
	NO. OF LOAD-TRANSFER CURVES(<12)?=						
	For each curve 1 to NCA:						
	CURVE						I5
	RATIO SHR DEV, M=1, 11 ARE						11F6.3
	MOVEMENT (IN.) FOR LOAD TRANSFER M=	IS	INCHES				I5,F6.3
11	(If I = 5)						
	NO OF SKIN FRICTION-DEPTH TERMS (<12)? ARE						I5
	SKIN FRICTION (PSF) DEPTH(FT) CURVE NO						F10.3,F10.3,I5
12	If J = 0)						
	E SHAFT (PSF) AND DEPTH(FT):						4(E13.3,2X,F6.2)
13	(If K = 6)						
	BASE DISPLACEMENT(IN.), BASE LOAD(LB) > FOR POINTS						F10.2,I5

b. Output Calculations

Line	Input Parameters			Format Statement
1	BEARING CAPACITY=	POUNDS		F13.2
2	DOWNWARD DISPLACEMENT			
3	(Omitted unless LO = 0,1)	POINT BEARING(LB)=		F13.2

(Sheet 1 of 3)

Table C-3 (Continued)

Line	Input Parameters					Format Statement
4	(Omitted unless LO = 0,1) DEPTH FT LOAD TRANS LB 5E13.5,I5	TOTAL LOAD	COM OF INCR LB	TOTAL MOVMT INCHES		INCHE S
5	TOP LOAD LB	TOP MOVEMENT INCHES	BASE LOAD LB	BASE MOVEMENT INCHES	4E13.5	
6	NEGATIVE UPWARD DISPLACEMENT					
7	TOP LOAD LB	TOP MOVEMENT INCHES	BASE LOAD LB	BASE MOVEMENT INCHES	E13.5	
8	STRUC LOAD (LB) (Line 14 of Table C-2)	SOILP (PSF)	ACTIVE DEPTH (FT)		F10.0,2F10.2	
9	BELL RESTRAINT(LB)=					F13.2
10	(If STRUL < 0.0 FIRST ESTIMATE OF PULLOUT RESTRAINT(LB)=	See Line 14, Table C-2)			F13.2	
11	LOAD-DISPLACEMENT BEHAVIOR					
12	(If LO <2) EFFECTS OF ADJACENT SOIL					
13	INITIAL BASE FORCE(LB)= (If LO = 0) BASE FORCE(LB)=				F13.2	
14	DISPLACEMENT (INCHES)=	FORCE=	POUNDS		F8.4,F12.2	
15	ITERATIONS=					I5
16	DEPTH(FT)	LOAD(LB)	SHAFT MVMT(IN)	SOIL MVMT(IN)		F7.2,2X,E13.5, 2F15.5

c. Description of Calculations

Line	Program Prints	Description
1	BEARING CAP...	End-bearing capacity, pounds
2	DOWNWARD DISPL	Load-displacement behavior for zero soil movement in downward direction for IJ points
3	POINT BEARING	Load at bottom of shaft prior to shaft load-transfer calculation, pounds
4	DEPTH LOAD TRANS TOTAL LOAD COM OF INCR TOTAL MOVMT INTER	Depth, ft Load transferred at given depth along shaft, pounds Total load on shaft at given depth, pounds Incremental shaft compression at given depth, inches Shaft-soil relative movement at given depth, inches Number of iterations to complete calculations
5	TOP LOAD TOP MOVEMENT BASE LOAD BASE MOVEMENT	Load at top of shaft, pounds Displacement at top of shaft, inches Load at bottom of shaft, pounds Displacement at bottom of shaft, inches

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Table C-3 (Concluded)

Line	Input Parameters	Format Statement
6	NEGATIVE UPWARD	Load-displacement behavior for zero soil movement in upward direction for IJ points
7	Same as item 5	
8	STRUC LOAD(LB) SOILP(PSF) ACTIVE DEPTH	Load applied on top of shaft, pounds Pressure applied on top of adjacent soil, psf Depth of soil beneath ground surface subject to soil heave, ft
9	BELL RESTRAINT	Restraining resistance of bell, pounds
10	FIRST ESTIMATE	Initial calculations of pullout resistance prior to iterations for structural loads less than zero, pounds
11	LOAD-DISPLACE	Load-shaft movement distribution for given structural load
12	EFFECTS OF ADJ	Effects of soil movement considered in load-displacement behavior
13	INITIAL BASE	Initial calculation of force at bottom of shaft prior to iterations
14	DISPLACEMENT FORCE=	Displacement at bottom of shaft after 100 iterations, inches Force at bottom of shaft, pounds after 100 iterations, pounds
15	ITERATIONS	Total number of iterations to converge to solution
16	DEPTH(FT) LOAD(LB) SHAFT MVMT(IN.) SOIL MVMT(IN.)	Depth, feet Load at given depth, pounds Shaft displacement, inches Soil movement, inches

(Sheet 3 of 3)

(2) Load-transfer models. The Seed and Reese skin friction and Reese and Wright base load-transfer models were selected ($K = 2$). Two points for the elastic modulus of the shaft concrete were input into the program.

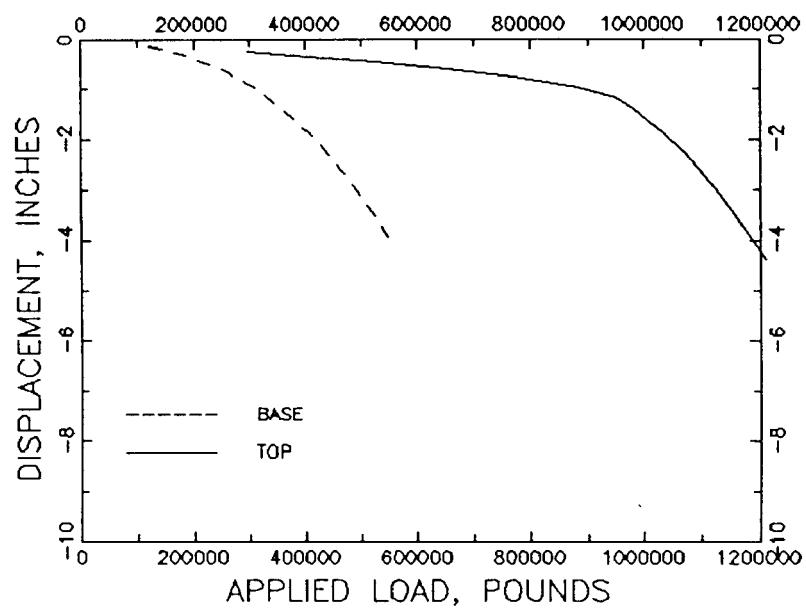
(3) Results. The results are plotted in Figure C-3 for a downward applied load of 150 kips. Results of the computation placed in file LTROUT.TXT are illustrated in Table C-7.

(a) Total and base ultimate bearing capacity (Figure C-3a) is about 550 and 880 kips, respectively. Base and total capacity is about 200 and 500 kips, respectively, if settlement is limited to 0.5 inch. The FS

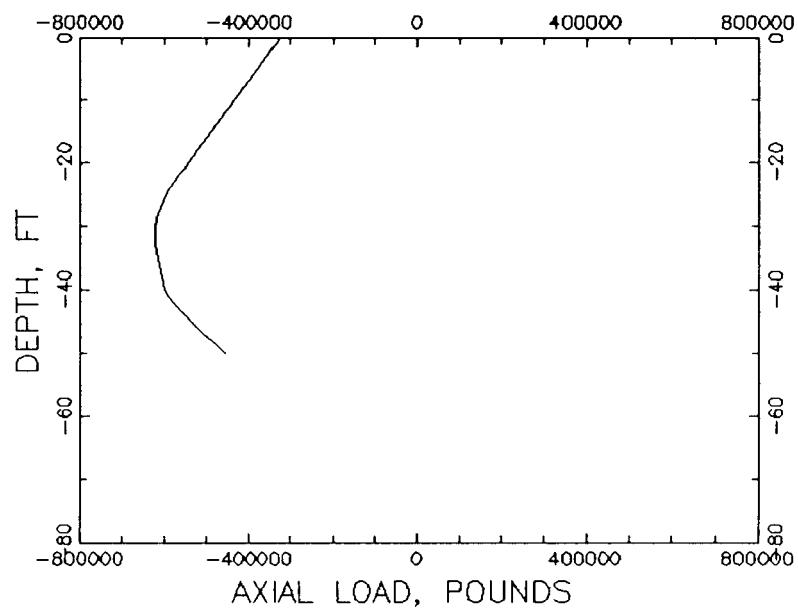
is approximately 1.8 relative to total pile capacity. The program does not add the vertical plunging failure liens to the curves in Figure C-3a, which leaves the calculated displacement load relationships nearly linear.

(b) The distribution of load with depth (Figure C-3b) is representative of downdrag indicated in Figure 3-21. The load on the shaft base is nearly 300 kips or double the applied load at the ground surface.

(c) The shaft will settle approximately 1 inch, while the soil settles about 2 inches at the ground surface (Figure C-3c). The soil is heaving near the ground surface, which counters the settlement from downdrag. Maximum settlement is about 3.5 inches at 10 feet of depth.



a. LOAD-DISPLACEMENT BEHAVIOR, FILE LD COM



b. AXIAL LOAD-DEPTH BEHAVIOR, FILE LDEP

Figure C-2. Plotted output for pullout and uplift problems (Continued)

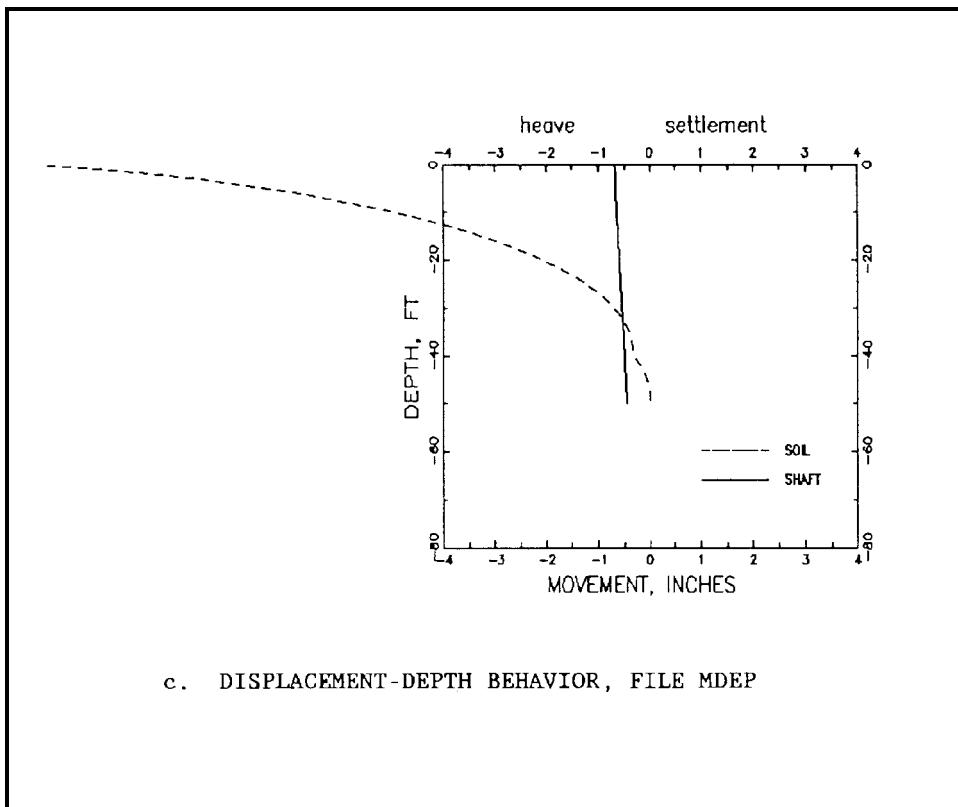


Figure C-2. (Concluded)

Table C-4
Listing of Data Input for Expansive Soil, File DATLR.TXT

EXPANSIVE SOIL										
2	50	1.0	40.	2	50	16				
6	0	8		0.0	2.0		5.00			
0										
1	2.68	.8		30.	4800.	.1	.2	2000.	.0	.7
2	2.65	.37		13.1	6000.	.1	.2	4000.	.0	2.
	0.9			0.9						7000.
	1	1								10000.
	41	2								
	50	2								
	.900		1.600E+05							
	2									
	4.333E 08	.0								
	4.333E 08	50.0								
-300000.		.0		50.						
0.		.0			-1.0					
0										

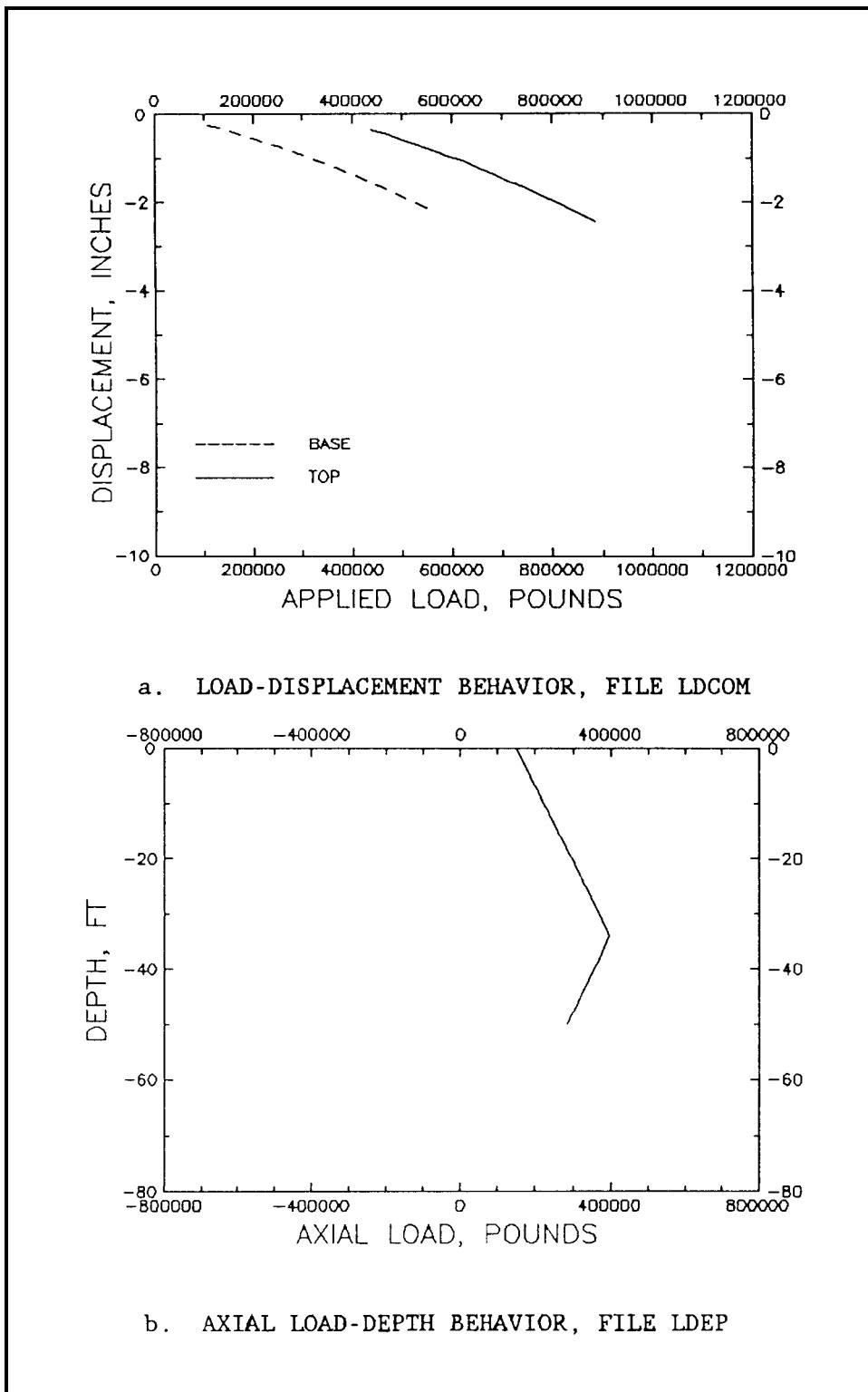
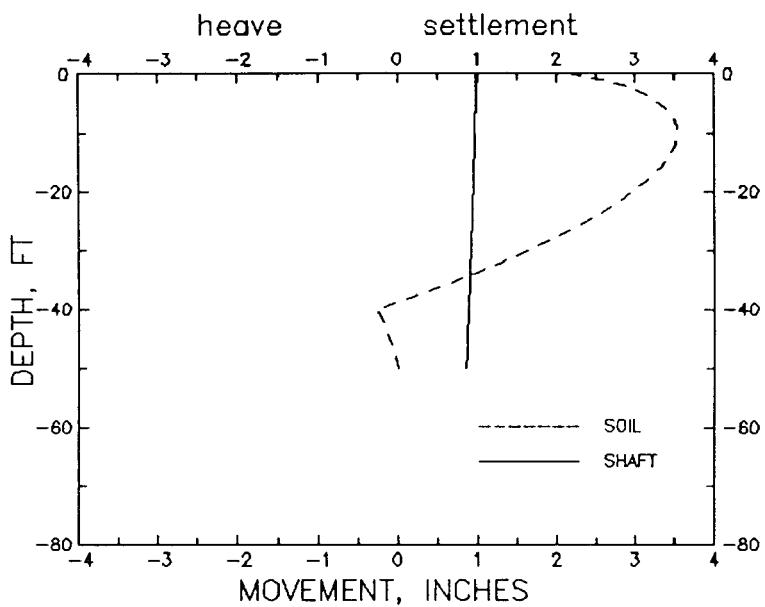


Figure C-3. Plotted output for drowndrag problem



c. DISPLACEMENT-DEPTH BEHAVIOR, FILE MDEP

Figure C-3. (Concluded)

Table C-5
Listing of Output for Pullent and Uplift Problem

EXPANSIVE SOILS										
NMAT=	2	NEL=	50	DX=	1.00 FT	GWL=	40.00 FT			
LO=	2	IQ	(SHAFT INC)=	50	IJ	(NO. LOADS)=	16			
I=	6	J=	0	K=	8	SOILP=	0.00 PSF			
DS=			2.00 FT							
DB=			5.00 FT							
LOCAL SHEAR FAILURE AT BASE - LLL= 0										
MAT	GS	EO	WO(%)	PS(PSF)	CS	CC	CO(PSF)	PHI	K	PM(PSF)
1	2.68	0.80	30.00	4800.	0.10	0.20	2000.	0.00	0.70	7000.
2	2.65	0.37	13.10	6000.	0.10	0.20	4000.	0.00	2.00	100000.
ALPHA=			0.90000		0.90000					
ELEMENT			NO OF SOIL							
1			1							
2			1							
.			1							
40			1							
41			2							
42			2							
.			2							
50			2							
REDUCTION FACTOR = 0.900 SHEAR MODULUS= 0.160E+06										
E SHAFT(PSF) AND DEPTH(FT): 0.433E+09 0.00 0.433E+09 50.00										
BEARING CAPACITY= 549778.69 POUNDS										
DOWNWARD DISPLACEMENT										
TOP LOAD POUNDS		TOP MOVEMENT INCHES			BASE LOAD POUNDS			BASE MOVEMENT INCHES		
0.24017E+06		0.17714E+00			0.10946E+06			0.99065E-01		
0.34507E+06		0.26781E+00			0.13882E+06			0.15855E+00		
0.45773E+06		0.37719E+00			0.16817E+06			0.23526E+00		
0.58421E+06		0.50996E+00			0.19753E+06			0.33139E+00		
0.71040E+06		0.66509E+00			0.22688E+06			0.44915E+00		
0.82982E+06		0.84256E+00			0.25624E+06			0.59070E+00		
0.92817E+06		0.10432E+01			0.28559E+06			0.75826E+00		
0.97601E+06		0.12587E+01			0.31494E+06			0.95401E+00		
0.10054E+07		0.14978E+01			0.34430E+06			0.11801E+01		
0.10347E+07		0.17694E+01			0.37365E+06			0.14388E+01		
0.10641E+07		0.20758E+01			0.40301E+06			0.17323E+01		
0.10934E+07		0.24192E+01			0.43236E+06			0.20627E+01		
0.11228E+07		0.28017E+01			0.46172E+06			0.24323E+01		
0.11521E+07		0.32256E+01			0.49107E+06			0.28432E+01		
0.11815E+07		0.36930E+01			0.52042E+06			0.32977E+01		
0.12108E+07		0.42061E+01			0.54978E+06			0.37979E+01		

(Sheet 1 of 3)

Table C-5 (Continued)

NEGATIVE UPWARD DISPLACEMENT

TOP LOAD POUNDS	TOP MOVEMENT INCHES	BASE LOAD POUNDS	BASE MOVEMENT INCHES
-0.18590E+05	-0.37138E-02	0.00000E+00	0.00000E+00
-0.31134E+05	-0.16708E-01	0.00000E+00	-0.10000E-01
-0.43689E+05	-0.29706E-01	0.00000E+00	-0.20000E-01
-0.68793E+05	-0.55704E-01	0.00000E+00	-0.40000E-01
-0.11899E+06	-0.10770E+00	0.00000E+00	-0.80000E-01
-0.21806E+06	-0.21160E+00	0.00000E+00	-0.16000E+00
-0.38024E+06	-0.41089E+00	0.00000E+00	-0.32000E+00
-0.61240E+06	-0.78911E+00	0.00000E+00	-0.64000E+00
-0.69610E+06	-0.14531E+01	0.00000E+00	-0.12800E+01
-0.69610E+06	-0.27331E+01	0.00000E+00	-0.25600E+01
-0.69610E+06	-0.52931E+01	0.00000E+00	-0.51200E+01
-0.69610E+06	-0.10413E+02	0.00000E+00	-0.10240E+02
-0.69610E+06	-0.20653E+02	0.00000E+00	-0.20480E+02
-0.69610E+06	-0.41133E+02	0.00000E+00	-0.40960E+02
-0.69610E+06	-0.82093E+02	0.00000E+00	-0.81920E+02
-0.69610E+06	-0.16401E+03	0.00000E+00	-0.16384E+03
STRUC LOAD(LB) -300000.	SOILP(PSF) 0.00	ACTIVE DEPTH(FT) 50.00	
BELL RESTRAINT(LB)=		44915.44	
FIRST ESTIMATE OF PULLOUT RESTRAINT(LB)=		541894.31	

LOAD-DISPLACEMENT BEHAVIOR

INITIAL BASE FORCE(LBS)=	-788275.25		
DISPLACEMENT(INCHES)=	-0.2475	FORCE=	-66776819 POUNDS
DISPLACEMENT(INCHES)=	-0.4975	FORCE=	-532357.44 POUNDS
DISPLACEMENT(INCHES)=	-0.6525	FORCE=	-449443.94 POUNDS

INTERATIONS= 262

DEPTH(FT)	LOADS(LB)	SHAFT MVMT(IN.)	SOIL MVMT(IN.)
0.00	-0.32427E+06	-0.88276	-11.94514
1.00	-0.33520E+06	-0.87985	-10.67843
2.00	-0.34613E+06	-0.87685	-9.72980
3.00	-0.35706E+06	-0.87385	-8.92906
4.00	-0.36799E+06	-0.87055	-8.22575
5.00	-0.37892E+06	-0.86726	-7.59519
6.00	-0.38985E+06	-0.86387	-7.02274
7.00	-0.40078E+06	-0.86039	-6.49865
8.00	-0.41171E+06	-0.85681	-6.01600
9.00	-0.42264E+06	-0.85313	-5.56958
10.00	-0.43357E+06	-0.84936	-5.15537
11.00	-0.44450E+06	-0.84549	-4.77014
12.00	-0.45543E+06	-0.84152	-4.41124
13.00	-0.46636E+06	-0.83746	-4.07648
14.00	-0.47729E+06	-0.83330	-3.76401
15.00	-0.48822E+06	-0.82904	-3.47223
16.00	-0.49915E+06	-0.82469	-3.19976

(Sheet 2 of 3)

Table C-5 (Concluded)

DEPTH(FT)	LOADS(LB)	SHAFT MVMT(IN.)	SOIL MVMT(IN.)
17.00	-0.51008E+06	-0.82024	-2.94538
18.00	-0.52101E+06	-0.81570	-2.70805
19.00	-0.53194E+06	-0.81105	-2.48680
20.00	-0.54287E+06	-0.80632	-2.28080
21.00	-0.55380E+06	-0.80148	-2.08927
22.00	-0.56473E+06	-0.79655	-1.91153
23.00	-0.57566E+06	-0.79153	-1.74696
24.00	-0.58613E+06	-0.78641	-1.59498
25.00	-0.59556E+06	-0.78120	-1.45506
26.00	-0.60381E+06	-0.77591	-1.32673
27.00	-0.61073E+06	-0.77056	-1.20953
28.00	-0.61621E+06	-0.76515	-1.10306
29.00	-0.62027E+06	-0.75970	-1.00692
30.00	-0.62304E+06	-0.75422	-0.92078
31.00	-0.62444E+06	-0.74872	-0.84428
32.00	-0.62465E+06	-0.74321	-0.77713
33.00	-0.62386E+06	-0.73771	-0.71902
34.00	-0.62223E+06	-0.73222	-0.66969
35.00	-0.61992E+06	-0.72674	-0.62887
36.00	-0.61710E+06	-0.72129	-0.59633
37.00	-0.61390E+06	-0.71587	-0.57183
38.00	-0.61049E+06	-0.71047	-0.55516
39.00	-0.60701E+06	-0.70510	-0.54610
40.00	-0.60360E+06	-0.69977	-0.54447
41.00	-0.59487E+06	-0.69448	-0.46514
42.00	-0.58401E+06	-0.68929	-0.39155
43.00	-0.57119E+06	-0.68420	-0.32363
44.00	-0.55675E+06	-0.67922	-0.26128
45.00	-0.54103E+06	-0.67439	-0.20443
46.00	-0.52416E+06	-0.66969	-0.15300
47.00	-0.50642E+06	-0.66515	-0.10692
48.00	-0.48799E+06	-0.66077	-0.06611
49.00	-0.46897E+06	-0.65655	-0.03049
50.00	-0.44994E+06	-0.65250	0.00000
STRUC LOAD(LB)	SOILP(PSF)	ACTIVE DEPTH(FT)	
0.	0.00	-1.00	

(Sheet 3 of 3)

Table C-6
Listing of Data Input for Settling Soil

SETTLING SOIL											
2	50	1.0	40.	0.0	2	50	16				
6	0	2			2	2.0					
							5.00				
	0.010										
	0										
1	2.68	.8		30.		1200.	.05	.1	2000.	.0	.7
2	2.65	.37		13.1		6000.	.05	.1	4000.	.0	2.
	0.55			0.3							
	1	1									
	41	2									
	50	2									
	2										
	4.333E 08	.0									
	4.333E 08	50.0									
	150000.										
	0.										
	0										
							50.				

Table C-7
Listing of Output for Downdrag Problem

SETTLING SOILS											
NMAT=	2	NEL=	50	DX=	1.00 FT	GWL=	40.00 FT				
LO=	2	IQ	(SHAFT INC)=	50	IJ	(NO. LOADS)=	16				
I=	6	J=	0	K=	8	SOILP=	0.00 PSF				
DS=			2.00 FT								
DB=			5.00 FT								
E50=			0.100E-01								
LOCAL SHEAR FAILURE AT BASE - LLL= 0											
MAT	GS	EO	WO(%)	PS(PSF)	CS	CC	CO(PSF)	PHI	K	PM(PSF)	
1	2.68	0.80	30.00	1200.	0.05	0.10	2000.	0.00	0.70	4000.	
2	2.65	0.37	13.10	6000.	0.05	0.10	4000.	0.00	2.00	10000.	
ALPHA=		0.55000		0.3000							

Table C-7 (Continued)

ELEMENT	NO OF SOIL
1	1
2	1
.	1
.	1
40	1
41	2
42	2
.	2
.	2
50	2

E SHAFT(PSF) AND DEPTH(FT):

0.433E+09 0.00 0.433E+09 50.00
BEARING CAPACITY= 549778.69 POUNDS

DOWNTWARD DISPLACEMENT

TOP LOAD POUNDS	TOP MOVEMENT INCHES	BASE LOAD POUNDS	BASE MOVEMENT INCHES
0.43825E+06	0.36209E+00	0.10946E+06	0.24071E+00
0.47316E+06	0.46787E+00	0.13882E+06	0.33163E+00
0.50252E+06	0.57771E+00	0.16817E+06	0.42854E+00
0.53187E+06	0.69319E+00	0.19753E+06	0.53108E+00
0.56122E+06	0.81401E+00	0.22688E+06	0.63896E+00
0.59058E+06	0.93992E+00	0.25624E+06	0.75193E+00
0.61993E+06	0.10707E+01	0.28559E+06	0.86977E+00
0.64929E+06	0.12061E+01	0.31494E+06	0.99228E+00
0.67864E+06	0.13461E+01	0.34430E+06	0.11193E+01
0.70800E+06	0.14904E+01	0.37365E+06	0.12507E+01
0.73735E+06	0.16389E+01	0.40301E+06	0.13862E+01
0.76671E+06	0.17945E+01	0.43236E+06	0.15259E+01
0.79606E+06	0.19481E+01	0.46172E+06	0.16695E+01
0.82541E+06	0.21085E+01	0.49107E+06	0.18170E+01
0.85477E+06	0.22727E+01	0.52042E+06	0.19682E+01
0.88412E+06	0.24405E+01	0.54978E+06	0.21231E+01

(Sheet 2 of 4)

Table C-7 (Continued)

NEGATIVE UPWARD DISPLACEMENT

TOP LOAD POUNDS	TOP MOVEMENT INCHES	BASE LOAD POUNDS	BASE MOVEMENT INCHES
-0.19877E+05	-0.38437E-02	0.00000E+00	0.00000E+00
-0.44463E+05	-0.18937E-01	0.00000E+00	-0.10000E-01
-0.69052E+05	-0.34038E-01	0.00000E+00	-0.20000E-01
-0.11821E+06	-0.64239E-01	0.00000E+00	-0.40000E-01
-0.21272E+06	-0.12447E+00	0.00000E+00	-0.80000E-01
-0.31375E+06	-0.22746E+00	0.00000E+00	-0.16000E+00
-0.36937E+06	-0.40225E+00	0.00000E+00	-0.32000E+00
-0.36937E+06	-0.72225E+00	0.00000E+00	-0.64000E+00
-0.36937E+06	-0.13623E+01	0.00000E+00	-0.12800E+01
-0.36937E+06	-0.26423E+01	0.00000E+00	-0.25600E+01
-0.36937E+06	-0.52023E+01	0.00000E+00	-0.51200E+01
-0.36937E+06	-0.10322E+02	0.00000E+00	-0.10240E+02
-0.36937E+06	-0.20562E+02	0.00000E+00	-0.20480E+02
-0.36937E+06	-0.41042E+02	0.00000E+00	-0.40960E+02
-0.36937E+06	-0.82002E+02	0.00000E+00	-0.81920E+02
-0.36937E+06	-0.16392E+02	0.00000E+00	-0.16384E+03
STRUC LOAD(LB) 150000.	SOILP(PSF) 0.00	ACTIVE DEPTH(FT) 50.00	
BELL RESTRAINT(LB)=		44915.44	
LOAD-DISPLACEMENT BEHAVIOR			
POINT BEARING(LB)=	37465.96		

DEPTH FEET	LOAD TRANS POUNDS	TOTAL LOAD POUNDS	COM OF INCR INCHES	TOTAL MVMT INCHES	ITER
0.49500E+02	0.35018E+04	0.40968E+05	0.34571E-03	0.82732E-01	2
0.48500E+02	0.35181E+04	0.44486E+05	0.37665E-03	0.83108E-01	2
0.47500E+02	0.35358E+04	0.48022E+05	0.40775E-03	0.83516E-01	2
0.46500E+02	0.35550E+04	0.51577E+05	0.43900E-03	0.83955E-01	2
0.45500E+02	0.35756E+04	0.55152E+05	0.47043E-03	0.84425E-01	2
0.44500E+02	0.35976E+04	0.58750E+05	0.50205E-03	0.84928E-01	2
0.43500E+02	0.36210E+04	0.62371E+05	0.53386E-03	0.85461E-01	2
0.42500E+02	0.36459E+04	0.66017E+05	0.56589E-03	0.86027E-01	2
0.41500E+02	0.36722E+04	0.69689E+05	0.59815E-03	0.86625E-01	2
0.40500E+02	0.37000E+04	0.73389E+05	0.63064E-03	0.87256E-01	2
0.39500E+02	0.32524E+04	0.76641E+05	0.66129E-03	0.87917E-01	2
0.38500E+02	0.32804E+04	0.79921E+05	0.69008E-03	0.88607E-01	2
0.37500E+02	0.33096E+04	0.83231E+05	0.71913E-03	0.89327E-01	2
0.36500E+02	0.33400E+04	0.86571E+05	0.74844E-03	0.90075E-01	2
0.35500E+02	0.33717E+04	0.89943E+05	0.77802E-03	0.90853E-01	2
0.34500E+02	0.34046E+04	0.93347E+05	0.80789E-03	0.91661E-01	2
0.33500E+02	0.34378E+04	0.96786E+05	0.83805E-03	0.92499E-01	2
0.32500E+02	0.34741E+04	0.10026E+06	0.86852E-03	0.93368E-01	2
0.31500E+02	0.35107E+04	0.10377E+06	0.89931E-03	0.94267E-01	2

(Sheet 3 of 4)

Table C-7 (Continued)

0.30500E+02	0.35487E+04	0.10732E+06	0.93042E-03	0.95197E-01	2
0.29500E+02	0.35879E+04	0.11091E+06	0.96188E-03	0.96159E-01	2
0.28500E+02	0.36284E+04	0.11454E+06	0.99369E-03	0.97153E-01	2
0.27500E+02	0.36703E+04	0.11821E+06	0.10259E-02	0.98179E-01	2
0.26500E+02	0.37135E+04	0.12192E+06	0.10584E-02	0.99237E-01	2
0.25500E+02	0.37581E+04	0.12568E+06	0.10913E-02	0.10033E+00	2
0.24500E+02	0.37857E+04	0.12946E+06	0.11246E-02	0.10145E+00	2
0.23500E+02	0.38093E+04	0.13327E+06	0.11581E-02	0.10261E+00	2
0.22500E+02	0.38337E+04	0.13711E+06	0.11918E-02	0.10380E+00	2
0.21500E+02	0.38588E+04	0.14097E+06	0.12257E-02	0.10503E+00	2
0.20500E+02	0.38845E+04	0.14485E+06	0.12598E-02	0.10629E+00	2
0.19500E+02	0.39110E+04	0.14876E+06	0.12941E-02	0.10758E+00	2
0.18500E+02	0.39382E+04	0.15270E+06	0.13287E-02	0.10891E+00	2
0.17500E+02	0.39661E+04	0.15667E+06	0.13636E-02	0.11027E+00	2
0.16500E+02	0.39947E+04	0.16066E+06	0.13987E-02	0.11167E+00	2
0.15500E+02	0.40241E+04	0.16468E+06	0.14340E-02	0.13111E+00	2
0.14500E+02	0.40542E+04	0.16874E+06	0.14696E-02	0.11458E+00	2
0.13500E+02	0.40850E+04	0.17282E+06	0.15055E-02	0.11608E+00	2
0.12500E+02	0.41166E+04	0.17694E+06	0.15417E-02	0.11762E+00	2
0.11500E+02	0.41490E+04	0.18109E+06	0.15781E-02	0.11920E+00	2
0.10500E+02	0.41821E+04	0.18527E+06	0.16148E-02	0.12082E+00	2
0.95000E+01	0.42159E+04	0.18949E+06	0.16518E-02	0.12247E+00	2
0.85000E+01	0.42506E+04	0.19374E+06	0.16891E-02	0.12416E+00	2
0.75000E+01	0.42860E+04	0.19802E+06	0.17268E-02	0.12588E+00	2
0.65000E+01	0.43222E+04	0.20235E+06	0.17647E-02	0.12765E+00	2
0.55000E+01	0.43592E+04	0.20670E+06	0.18030E-02	0.12945E+00	2
0.45000E+01	0.43970E+04	0.21110E+06	0.18416E-02	0.13129E+00	2
0.35000E+01	0.44355E+04	0.21554E+06	0.18805E-02	0.13317E+00	2
0.25000E+01	0.44749E+04	0.22001E+06	0.19198E-02	0.13509E+00	2
0.15000E+01	0.45152E+04	0.22453E+06	0.19594E-02	0.13705E+00	2
0.50000E+00	0.45562E+04	0.22908E+06	0.19994E-02	0.13905E+00	2

(Sheet 4 of 4)

Table C-7 (Concluded)

INITIAL BASE FORCE(LB)= 355177.69

ITERATIONS= 81

DEPTH(FT)	LOADS(LB)	SHAFT MVMT(IN.)	SOIL MVMT(IN.)
0.00	0.14992E+06	0.98875	2.15238
1.00	0.15721E+06	0.98740	2.58505
2.00	0.16451E+06	0.98598	2.85868
3.00	0.17108E+06	0.98450	3.05836
4.00	0.17909E+06	0.98295	3.20933
5.00	0.18638E+06	0.98134	3.32392
6.00	0.19367E+06	0.97967	3.40946
7.00	0.20096E+06	0.97793	3.47082
8.00	0.20852E+06	0.97612	3.51146
9.00	0.21554E+06	0.97425	3.53398
10.00	0.22283E+06	0.97232	3.54040
11.00	0.23013E+06	0.97033	3.53233
12.00	0.23742E+06	0.96827	3.51109
13.00	0.24471E+06	0.96614	3.47778
14.00	0.25200E+06	0.96395	3.43333
15.00	0.25929E+06	0.96170	3.97853
16.00	0.26658E+06	0.95938	3.31409
17.00	0.27387E+06	0.95700	3.24058
18.00	0.28116E+06	0.95455	3.15857
19.00	0.28845E+06	0.95204	3.06850
20.00	0.29575E+06	0.94946	2.97082
21.00	0.30304E+06	0.94683	2.86589
22.00	0.31033E+06	0.94412	2.75408
23.00	0.31762E+06	0.94135	2.63568
24.00	0.32491E+06	0.93852	2.51098
25.00	0.33220E+06	0.93563	2.38025
26.00	0.33949E+06	0.93267	2.24373
27.00	0.34678E+06	0.92964	2.10165
28.00	0.35407E+06	0.92655	1.95420
29.00	0.36137E+06	0.92340	1.80157
30.00	0.36866E+06	0.92018	1.64396
31.00	0.37595E+06	0.91690	1.48152
32.00	0.38324E+06	0.91355	1.31441
33.00	0.39019E+06	0.91014	1.14278
34.00	0.39292E+06	0.90669	0.96503
35.00	0.38861E+06	0.90325	0.77876
36.00	0.38207E+06	0.89985	0.58423
37.00	0.37554E+06	0.89651	0.38165
38.00	0.36901E+06	0.89323	0.17124
39.00	0.36248E+06	0.89000	-0.04679
40.00	0.35595E+06	0.88684	-0.27224
41.00	0.34864E+06	0.88373	-0.23257
42.00	0.34133E+06	0.88069	-0.19578
43.00	0.33403E+06	0.87771	-0.16181
44.00	0.32672E+06	0.87480	-0.13064
45.00	0.31941E+06	0.87195	-0.10222
46.00	0.31211E+06	0.86917	-0.07650
47.00	0.30480E+06	0.86645	-0.05346
48.00	0.29749E+06	0.86380	-0.03305
49.00	0.29018E+06	0.86121	-0.01524
50.00	0.28288E+06	0.85868	0.00000
STRUC LOAD(LB)	SOILP(PSF)	ACTIVE DEPTH(FT)	
0.	0.00	-1.00	

(Sheet 5 of 4)